Section 3. Longitudinal Separation

8-3-1. APPLICATION

Separate aircraft by providing a time or distance interval between aircraft consistent with the required minima. Longitudinal separation expressed in distance may be applied as prescribed in Chapter 6, Nonradar.

NOTE-
Longitudinal separation minima is contained in:
Section 7. North Atlantic ICAO Region.
Section 8. Caribbean ICAO Region.
Section 9. Pacific ICAO Region.
Section 10. North American ICAO Region- Arctic CTA.

8-3-2. SEPARATION METHODS

Separate aircraft longitudinally in accordance with the following:

a. Same courses. Ensure that the spacing between aircraft is not less than the applicable minimum required. (See FIG 8-3-1.)

Same Courses

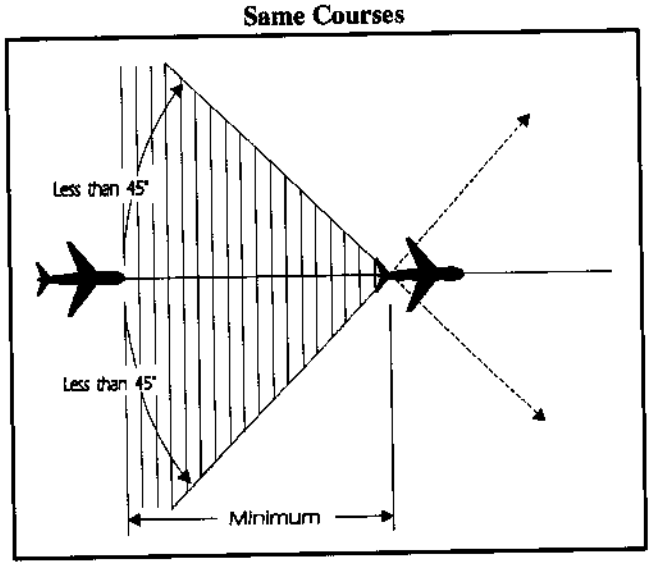

FIG 8-3-1

b. Crossing courses. Ensure that the spacing at the point of intersection is not less than the applicable minimum required. (See FIG 8-3-2.)

Crossing Courses

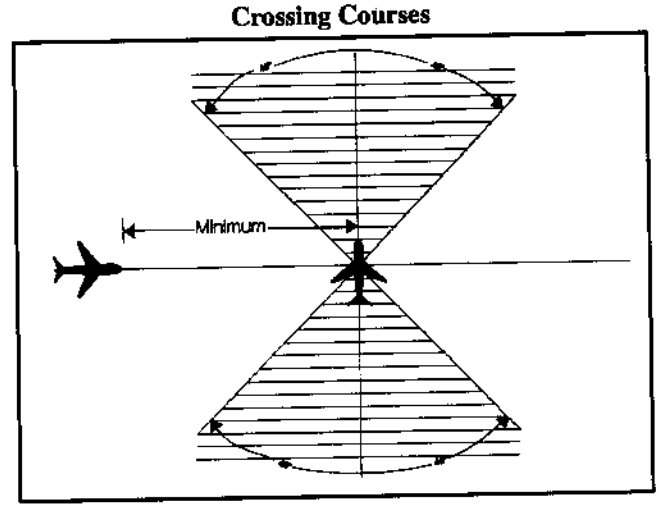

FIG 8-3-2

c. Reciprocal courses:

1. Ensure that aircraft are vertically separated for a time interval equal to the applicable minimum required before and after the aircraft are estimated to pass. (See FIG 8-3-3.)

Reciprocal Courses

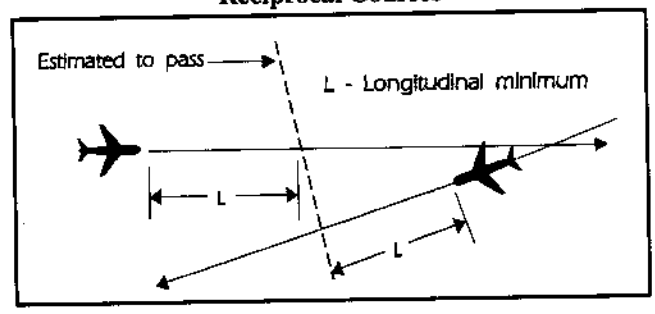

FIG 8-3-3

2. Vertical separation may be discontinued after one of the following conditions are met:

(a) Both aircraft have reported passing a significant point and the aircraft are separated by at least the applicable minimum required for the same direction longitudinal spacing; (See FIG 8-3-4.) or

Vertical Separation

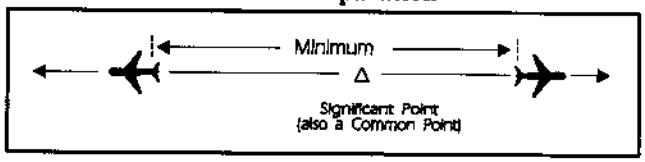

FIG 8-3-4

(b) Both aircraft have reported passing ground-based NAVAID's or DME fixes indicating that they have passed each other.

8-3-3. MACH NUMBER TECHNIQUE

The following conditions shall be met when the Mach number technique is being applied:

a. **Aircraft Types:** Turbojet aircraft only.

b. **Routes:**

1. The aircraft follow the same track or continuously diverging tracks, and

2. The aircraft concerned have reported over a common point; or

3. If the aircraft have *not* reported over a common point, either radar or other approved means are used to ensure that the appropriate time interval will exist at the common point; or

4. If a common point does not exist, either radar or other approved means are used to verify that the appropriate time interval will exist at a significant point on each track from which the tracks continuously diverge.

c. Altitudes:

1. Assign only a single cardinal altitude to each aircraft.

2. The aircraft concerned are in level, climbing or descending flight.

d. Mach Number Assignment:

1. A Mach number (or, when appropriate, a range of Mach numbers) shall be issued to each aircraft.

NOTE-
1. *ICAO Doc 7030/4 requires pilots to strictly adhere to the last assigned Mach number (or range of Mach numbers), even during climbs and descents, unless revised by ATC.*

2. *When it is necessary to issue crossing restrictions to ensure the appropriate time interval, it may be impossible for an aircraft to comply with both the clearance to meet the crossing restrictions and the clearance to maintain a single, specific Mach number.*

REFERENCE-
ICAO DOC 9426-AN/924, Part II, Section 2, Para 2.3.4, Para 2.4.7, and Para 2.5.3.

EXAMPLE-
"Maintain Mach point eight four or greater."
"Maintain Mach point eight three or less."
"Maintain Mach point eight two or greater; do not exceed Mach point eight four."

e. Separation Criteria:

1. The use of Mach number technique allows for the application of reduced longitudinal separation minima. However, the prescribed longitudinal separation between successive aircraft flying at the same level shall be provided over the entry point *and* on a particular track or tracks, or exist when climb or descent to the level of another aircraft is accomplished into the area concerned.

2. The applicable longitudinal separation minima is maintained by:

(a) Ensuring that the spacing between the estimated positions of the aircraft is not less than the prescribed minimum.

(b) Continuously monitoring aircraft position reports and updating control estimates along the aircraft's track(s). If after establishing the Mach number technique between aircraft, control information indicates that less than the applicable minima between aircraft may exist, immediately:

(1) Issue crossing restrictions to ensure the appropriate longitudinal minima at the next significant point, or

(2) Assign revised Mach numbers appropriate for the estimated interval, or

(3) Establish vertical separation.

NOTE-
Control estimates are calculated by the controller using known wind patterns, previous aircraft transit times, pilot progress reports, and pilot estimates.

f. Relative Speeds:

1. The lead aircraft maintains the same or a greater Mach number than the following aircraft; or

2. If the following aircraft is faster than the lead aircraft, ensure that the appropriate time interval will exist until another form of separation is achieved.

NOTE-
A "rule-of-thumb" may be applied which allows clearances to be issued in a timely manner, provided the expected minimum longitudinal separation over the exit point is subsequently confirmed when the calculated flight progress strip data becomes available. This rule-of-thumb can be stated as follows: For each 600 NM in distance between the entry and exit points of the area where the Mach Number Technique is used, add 1 minute for each 0.01 difference in Mach number for the two aircraft concerned to compensate for the fact that the second aircraft is overtaking the first aircraft. (See TBL 8-3-1.)

Application of the Mach Number Technique When the Following Aircraft is Faster

Difference in Mach	*Distance to Fly and Separation (in Minutes) Required at Entry Point*				
	001-600 NM	*601-1200 NM*	*1201-1800 NM*	*1801-2400 NM*	*2401-3000 NM*
0.01	11	12	13	14	15
0.02	12	14	16	18	20
0.03	13	16	19	22	25
0.04	14	18	22	26	30
0.05	15	20	25	30	35
0.06	16	22	28	34	40
0.07	17	24	31	38	45
0.08	18	26	34	42	50
0.09	19	28	37	46	55
0.10	20	30	40	50	60

TBL 8-3-1